On the Methodic Habits of Insects when visiting Flowers.

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The following results of a series of observations are laid before the Society, as a factor to assist in the solution of the important, although hitherto somewhat neglected, question as to the extent to which insects confine their visits to one species of flower on one flight.

The perusal, in 1881, of Mr. Bennett's paper "On the Constancy of Insects in their Visits to Flowers"* first led me to pay attention to the matter; and I hope that my altogether independent observations will be found to supplement and corroborate his. Throughout all my observations I have endeavoured to adopt a method of procedure precisely identical with that described by Mr. Bennett. I regret that some of my earlier observations were not made so systematically as the later ones, and that I have been unable to distinguish between nearly all of the various species of Humble-Bee and between some of the species of plants.

Altogether I am able to record the movements of 76 insects whilst engaged in visiting at least 2400 flowers. It is not my intention to lay the details of each observation before the Society: these I hope to publish elsewhere†; but instead, I have been induced to condense the observations in the subjoined tabular form. In some respects this is preferable, as the eye more readily appreciates at a glance and elicits those points whence ultimate conclusions are drawn.

Of the following three Tables, the first relates to the Hive-Bee, the second to all the species of Lepidoptera, and the third to all the species of Humble-Bee which have been under observation. The Tables are all arranged upon one plan. The first column gives the number of the observation, the second the name of the insect, and the third the number of different plant-species which it visited. The next three columns show the number of times the insect visited each species (the highest numbers coming first), and the succeeding column shows the total number of flowers of all species visited whilst the insect was under obser-

* Read before the York Meeting of the British Association, 1881.

† See 'Entomologist,' July 1883, vol. xvi. p. 145.

vation*. The concluding column is intended to make plain the order in which the species were visited, and how many times each was visited consecutively, as well as the colour of their flowers. The colours are represented as follows :—

W = white, Y = yellow, R = red (of various tints), and B = blue.

A glance at these Tables will show plainly that a very decided preference exists among insects for a considerable number of consecutive visits to flowers of the same species.

No one, I think, who takes the trouble to wade through the details will deny that there is apparent in very many, if not in most of them, some powerful influence at work which induces insects, where possible, to continue visiting for a considerable time continuously the flowers of the same species of plant, neglecting meanwhile nearly all other sorts. Of course it is utterly impossible to say (without perhaps a microscopical examination of the pollen a bee brings home) whether one insect on one flight from its hive or nest confines itself exclusively or principally to one species of plant ; but, according to my observations, there seems to be great probability of its so doing.

So far as Table I. goes, it will be seen that the Hive-Bee is *perfectly* methodic in its habits ; and it seems therefore to follow

TABLE I.—Hive-Bee (*Apis mellifica*).

Number of observation.	Number of species visited.	1st sp.	2nd sp.	3rd sp.	Total number of flowers visited.	Order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.	
21.	1	14	.....	.....	14	14 Y.	All showing absolute constancy.
22.	1	14	.....	.....	14	14 Y.	
26.	1	?	.....	.....	?	? Y.	
29.	1	?	.....	.....	?	? Y.	
30.	1	23	.....	.....	23	23 Y.	
32.	1	117	.....	.....	117	117 Y.	
33.	1	43	.....	.....	43	43 Y.	
38.	1	47	.....	.....	47	47 Y.	
8.	8	258			258		

* The totals given in the Tables are not quite correct, as there are in each case certain observations in which the exact number of visits was not counted; and these of course could not be included. In the last column of TableIII. the bracketed "1st" and "2nd" indicate that those visits to which they are attached were to the 1st, 2nd, or 3rd species which the insect visited as the case may be.

Table II.—Lepidoptera.

Number of observation.	Name of species.	Number of species visited.	Number of visits to 1st species.	Number of visits to 2nd species.	Number of visits to 3rd species.	Total number of flowers visited.	Showing order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.
24.	*Vanessa urticæ*	1	19	.....	.....	19	19 Y.
31.	*Gonepteryx rhamni*	1	3	.....	.....	3	3 Y.
46.	*Argynnis*, ? sp. (small)	1	8	.....	.....	8	8 copper-coloured.
47.	,, ,, ...	1	?	.....	.....	?	? ,,
59.	*Colias*, ? sp.	2	4	2	.. ..	6	2 light Y, 4 Y.
60.	*Argynnis aglaia*	1	10	.....	.....	10	10 R.
62.	,, ,, ...	2	3	2	.....	5	2 B, 3 R.
67.	Moth, ? sp.....	2	2		.....	3	2 W, 1 R.
71.	*Parnassius Apollo*.....	1	4	....	.....	4	4 R.
72.	*Lycæna*, ? sp.	1	3	.....	.....	3	3 Y.
73.	*Argynnis lathonia*.....	1	27	.....	.....	27	27 Y.
75.	*Pieris brassicæ*	1	11	.....	.....	11	1 R, 10 Pink, same species.
12.		15	94	5	.....	99	

that this is the most valuable species to plants, and is also probably, on account of its methodic habits, enabled to get through the most work. Both my observations on this point and also Mr. Bennett's lead to almost exactly the same conclusion*. It would be interesting to ascertain whether the Ligurian Bee or Mr. Blow's newly introduced Cyprian Bee, both of which are said to be more productive than our common Hive-Bee, are equally methodic—they could hardly be more so. Eight insects which I watched visited altogether eight species of flowers 258 times, or an average of about 32 flowers each. This species of Bee is so perfectly methodic, that when I have carefully watched (as in observations No. 26 and 29) a number of individuals visiting frequently a variety of different flowers growing together, I have never yet been able to see a Hive-Bee change one species of flower for another; on the contrary, as in my best observation (No. 32), I have often seen flowers of another species, although often of the same colour, obviously rejected.

Table II. (Lepidoptera) shows a considerably greater degree of constancy than it would have done, judging from Mr. Bennett's observations, had I watched a larger number of species. In this class Mr. Bennett and I have, with two exceptions, observed different species. As it is, 12 individuals which I have had under observation have visited 99 flowers belonging to 15 species; but 94 of these flowers belonged to 12 species.

Table III. shows a fairly high degree of constancy or method on the part of the Humble-Bees, as 46 insects, of whose movements I have exact details, visited 1751 flowers belonging to 74 species; but 1605 of these flowers belonged to 46 species, 1733 belonged to 65 species, 1745 belonged to 70 species, and 1750 belonged to 73 species. Taking all my 55 observations together, it will be seen that one insect visited, whilst kept in sight, no less than 5 species of flower, 3 visited 4 species, 4 visited 3 species, 18 visited 2 species, whilst 29 (or rather more than half) visited one species only.

* Since the foregoing was written, however, I have observed a Hive-Bee that was not perfectly methodic. Near Saffron Walden I saw one visit *Anemone nemorosa* 1, *Ranunculus Ficaria* 1, *Anemone nemorosa* 1, and *Ranunculus Ficaria* again once, and was then lost. The only other flower out around was *Primula vulgaris*. This was very early in the spring (April 6th), at which time, as in the autumn, as I now have reason to believe, Bees are less systematic than at other times. The season this year, at the date named, was exceedingly unfavourable for Bees, and very few flowers were out.

TABLE III.—Humble-Bee, *Bombus* (many species).

Number of observation.	Name of species.	Number of species visited.	Number of visits to					Total number of flowers visited.	Showing order in which the species were visited, the colour of their flowers, and number of visits paid consecutively to each.
			1st species.	2nd species.	3rd species.	4th species.	5th species.		
1.	*Bombus scrimshiranus*	1	?	.....	.....	.....	.....	?	? Y.
2.	*Bombus*, ? sp.	1	?	.....	.....	.....	.....	?	? Purple.
3.	„	3	110	13	2	.....	.....	125	39 R, 2 R, 7, 3, 10, 3, 12, 1, 27, 2, 2, 1, 2, 14 (all red, 1st and 2nd alternately), 2 R (fresh sp.).
4.	„	4	55	51	5	3	.....	114	46 R, 6 R, 4 R (1st), 10 R (2nd), 1 R (1st), 5 Y, 4 R (2nd), 2 W, 19 R (2nd), 1 W (4th), 16 R (2nd).
5.	„	1	49	.....	.....	.....	.....	49	49 W.
6.	„	1	31	.....	.....	.....	.....	31	31 W.
7.	„	2	6	1	.....	.....	.....	7	5 Y, 1 R, 1 Y (1st).
8.	„	2	5	1	.....	.....	.....	6	5 R, 1 Y.
9.	„	1	6	.....	.....	.....	.....	6	6 R.
10.	„	5	about 200	5	3	1	1	about 210	22 Y, 1 Y, 34 Y (1st), 16 Y (1st), 1 Y (2nd), 10 Y (1st), ? Y (1st), 1 Y (2nd), 9 Y (1st), 1 R, ? Y (1st), ? Y (1st), 5 R.
11.	„	4	?	?	2	1	.....	?	1 B, ? R, 1 Pink, 1 W (2nd), ? B (1st), 2 ?
12.	„	3	?	2	2	.....	.....	?	2 R, 2 R, ? Bluish.
13.	„	3	?	?	?	.....	.....	?	? B, ? R, ? B (1st), 1 R.
14.	„	1	58	.....	.....	.....	.....	58	58 B.
15.	„	1	15	.....	.....	.....	.....	15	15 B.
16.	„	1	15	.....	.....	.....	.....	15	15 B.
17.	„	1	41	.....	.....	.....	.....	41	41 B.
18.	„	1	13	.....	.....	.....	.....	13	13 B.
19.	„	1	32	.....	.....	.....	.....	32	32 B.
20.	„	1	57	.....	.....	.....	.....	57	57 B.
23.	*Anthrophora acevorum*, Fabr.	1	5	.....	.....	.....	.....	5	5 Y.
25.	„ „	1	108	.....	.....	.....	.....	108	108 Y.
27.	*Bombus scrimshiranus*	2	?	?	.....	.....	.....	?	? Y, ? B (both many times alternately).

28.	*Anthrophora acervorum*, Fabr. ...	2	?	?	.....	.....	.....	?	? Y, ? B (both many times alternately).
34.	*Bombus*, ? sp.	2	52	1	.....	.....	.....	53	52 B, 1 B.
35.	„	1	7	.....	.....	.....	.....	7	7 R.
36.	„	1	9	.....	.....	.....	.....	9	9 R.
37.	„	1	11	.....	.....	.....	.....	11	11 R.
39.	„	1	4	.....	.....	.....	.....	4	4 Y.
40.	„	2	?	?	.....	.....	.....	?	? W, ? R.
41.	„	2	3	1	.....	.....	.....	4	2 R, 1 Y, 1 R (1st).
42.	„	2	12	11	.....	.....	.....	23	12 R, 11 W (two species of *Trifolium*).
43.	„	1	15	.....	.....	.....	.....	15	8 Purple, 2 W, 5 Purple (all *Digitalis purpurea*).
44.	„	1	8	.....	.....	.....	.....	8	8 B.
45.	„	1	over 50	.....	.....	.....	.....	over 50	Over 50 W.
48.	„	2	?	1	.....	.....	.....	?	? R, ? W (all *Trifolium hybridum* ?)
49.	„	1	27	.....	.....	.....	.....	27	27 B.
50.	„	1	10	.....	.....	.....	.....	10	10 B.
51.	„	1	6	.....	.....	.....	.....	6	6 B.
52.	„	2	43	1	.....	.....	.....	44	23 B, 1 R, 20 B (1st).
53.	„	1	20	.....	.....	.....	.....	20	20 R.
54.	„	3	131	1	1	.....	.....	133	86 B, 1 R, 8 B (1st), 1 R, 37 B (1st).
55.	„	2	34	1	.....	.....	.....	35	34 B, 1 B.
56.	„	2	25	1	.....	.....	.....	26	13 B, 1 R, 12 B (1st).
57.	„	4	90	2	1	1	.....	94	86 B, 1 R, 4 B (1st), 1 W, 2 B.
58.	„	2	45	25	.....	.....	.....	70	7 W, 5 W, 4, 2, 2, 1, 14, 6, 1, 7, 2, 4, 2, 12 (two species of Clover visited alternately).
61.	„	2	10	5	.....	.....	.....	15	5 R, 10 R.
63.	„	2	28	1	.....	.....	.....	29	28 B, 1 R.
64.	„	1	21	.....	.....	.....	.....	21	21 B.
65.	„	1	5	.....	.....	.....	.....	5	5 R.
66.	„	2	24	5	.....	.....	.....	29	13 R, 5 B, 11 R (1st).
68.	„	2	43	1	.....	.....	.....	44	43 R, 1 B.
69.	„	1	20	.....	.....	.....	.....	20	20 R.
70.	„	2	34	1	.....	.....	.....	35	34 R, 1 W.
74.	„	1	12	.....	.....	.....	.....	12	12 W.
55.		94	1605	131	16	6	1	1751	

TABLE III.—Humble-Bee, *Bombus* (many species).

Number of observation.	Name of species.	Number of species visited.	Number of visits to 1st species.	2nd species.	3rd species.	4th species.	5th species.	Total number of flowers visited.	[illegible]
1.	*Bombus scrimshiranus*	1	?	......	......	......	......	?	1 Y.
2.	*Bombus*, ? sp.	1	?	......	......	......	......	?	1 Purple.
3.	"	3	110	13	2	......	......	125	[illegible] R, 2 R, 7, 3, 10, 3, 12, 1, 27, 2, 2, 1, 2, 14 ([illegible] 1st and 2nd alternately), 2 R ([illegible]).
4.	"	4	55	51	5	3	......	114	[illegible], 10 R (2nd), 1 P (1st), [illegible] (2nd), 2 W, 19 R (2nd), 1 W (4th), 16 R (2nd).
5.	"	1	49	......	......	......	......	49	49 W.
6.	"	1	31	......	......	......	......	31	31 W.
7.	"	2	6	1	......	......	......	7	5 Y, 1 R, 1 Y (1st).
8.	"	2	5	1	......	......	......	6	5 R, 1 Y.
9.	"	1	6	......	......	......	......	6	6 R.
10.	"	5	about 200	5	3	1	1	about 210	22 Y, 1 Y, 34 Y (1st), 16 Y (1st), 1 Y (2nd), 10 Y (1st), ? Y (1st), 1 Y (2nd), 9 Y (1st), 1 R, ? Y (1st), ? Y (1st), 5 R.
11.	"	4	?	?	2	1	......	?	1 B, ? R, 1 Pink, 1 W (2nd), ? B (1st), 2 ?
12.	"	3	?	2	2	......	......	?	2 R, 2 R, ? Bluish.
13.	"	3	?	?	?	......	......	?	? B, ? R, ? B (1st), 1 R
14.	"	1	58	......	......	......	......	58	58 B.
15.	"	1	15	......	......	......	......	15	15 B.
16.	"	1	15	......	......	......	......	15	15 B.
17.	"	1	41	......	......	......	......	41	41 B.
18.	"	1	13	......	......	......	......	13	13 B.
19.	"	1	32	......	......	......	......	32	32 B.
20.	"	1	57	......	......	......	......	57	57 B.
23.	*Anthrophora acevorum*, Fabr. ...	1	5	......	......	......	......	5	5 Y.
25.	" "	1	108	......	......	......	......	108	108 Y.
27.	*Bombus scrimshiranus*	2	?	?	......	......	......	?	? Y, ? B (both many times alternately).
28.	*Anthrophora acevorum*, Fabr. ...	2	?	?	......	......	......	?	? Y, ? B (both many times [illegible]).
34.	*Bombus*, ? sp.	2	52	1	......	......	......	53	52 B, 1 B.
35.	"	1	7	......	......	......	......	7	7 B.
36.	"	1	9	......	......	......	......	9	9 B.
37.	"	1	11	......	......	......	......	11	11 R.
39.	"	1	4	......	......	......	......	4	4 Y.
40.	"	2	?	?	......	......	......	?	? W, ? R.
41.	"	2	3	1	......	......	......	4	2 R, 1 Y, 1 B (1st).
42.	"	2	12	11	......	......	......	23	12 R, 11 W ([illegible] *folium*).
43.	"	1	15	......	......	......	......	15	8 Purple, ? W, 5 Purple ([illegible]).
44.	"	1	8	......	......	......	......	8	8 B.
45.	"	1	over 50	......	......	......	......	over 50	Over 50 W.
48.	"	2	?	1	......	......	......	?	? R, ? W ([illegible]).
49.	"	1	27	......	......	......	......	27	27 B.
50.	"	1	10	......	......	......	......	10	10 B.
51.	"	1	6	......	......	......	......	6	6 B.
52.	"	2	43	1	......	......	......	44	23 B, 1 R, 20 B (1st).
53.	"	1	20	......	......	......	......	20	20 B.
54.	"	3	131	1	1	......	......	133	[illegible] B, 1 R, ? B (1st), 1 B, 27 B (1st).
55.	"	2	34	1	......	......	......	35	34 B, 1 B.
56.	"	2	25	1	......	......	......	26	13 B, 1 R, 12 B (1st).
57.	"	4	90	2	1	1	......	94	[illegible] B, 1 R, 4 B [illegible]
58.	"	2	45	25	......	......	......	70	7 W, 5 W, 4, 2, [illegible], 2, 4, 2, 12 (two species [illegible] visited alternately).
61.	"	2	10	5	......	......	......	15	5 R, 10 B.
63.	"	2	28	1	......	......	......	29	28 B, 1 B.
64.	"	1	21	......	......	......	......	21	21 B.
65.	"	1	5	......	......	......	......	5	5 B.
66.	"	2	24	5	......	......	......	29	13 B, 5 B, 11 B (1st).
68.	"	2	43	1	......	......	......	44	43 B, 1 B.
69.	"	1	20	......	......	......	......	20	20 B.
70.	"	2	34	1	......	......	......	35	34 B, 1 W.
74.	"	1	12	......	......	......	......	12	12 W.
55.		94	[illegible]	[illegible]	16	6	1	1751	

It will be observed that most of my observations have been made upon Bees, which seem to me to perform the fertilization of at least one half of all the flowers which are fertilized by insects in this country. As to Butterflies I have seldom seen one whose flight gave me the idea that the insect had the least notion as to where it was going. Generally their movements seem purposeless. Nevertheless some species, including the Fritillaries, are fairly methodic. Among the high Alps of the Canton Grisons, however, where some of my observations have been made, there are very few Bees when compared with what we have in England, whilst the number of Butterflies and Moths is so great that it hardly bears comparison with the number here. I presume, therefore, that a large number of plants growing on the Alps are fertilized by Lepidoptera, although I have only a very few observations to that effect, as insects of this class are most difficult and unsatisfactory to watch.

We have now seen that insects do possess a decided preference for a number of successive visits to the same species of flower, although this is not invariably the case. It is quite needless here to treat of the great importance of this fact to the plants themselves, or of the numerous variations and modifications of colour, form, scent, and other particulars which the plants appear to have effected in their flowers with a view of inducing the insects to be thus methodic in their habits. I cannot doubt that Mr. Darwin is right when, in speaking of the probable reasons why insects are methodic, he says ('Cross- and Self-fertilization of Flowers,' p. 419):—"The cause probably lies in the insects being thus enabled to work quicker; they have just learnt how to stand in the best position on the flower, and how far and in what direction to insert their proboscides. They act on the same principle as does an artificer who has to make half a dozen engines, and who saves time by making consecutively each wheel and part for all of them."

Although so little is really known as to the sight of insects, Sir John Lubbock's observations have satisfactorily established the fact that Bees can distinguish some at least of the colours, and that they show a preference for *blue*. Colour, however, is not the only sense which guides insects from one flower to another of the same species, although I believe it largely does so. Some other sense must have been called into use in observation No. 43, where a small Humble-Bee visited 15 flowers of *Digitalis purpurea*, some being white and others coloured; in obser-